CHAPTER 2

WETLANDS

WETLANDS

Jurisdictional Wetlands

Wetlands are included as surface waters of the Commonwealth in Kentucky water quality standards regulation 401 KAR 5:029. Wetlands are defined in that same regulation as land that has a predominance of hydric soils and that is inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions. All wetlands have three key attributes: (1) characteristic hydric soils that become flooded, saturated, or ponded long enough during the growing season to develop anaerobic conditions in the upper layers; (2) plants that tolerate and thrive in such conditions; and (3) a degree of flooding, saturation, or ponding during the growing season to sustain characteristic soils and vegetation. Jurisdictional wetlands are delineated by the U.S. Army Corps of Engineers (COE) in accordance with the COE Wetlands Delineation Manual (Technical Report Y-87-1, January 1987). Farmed wetlands, prior converted croplands, and other agricultural lands where the natural vegetation has been removed are delineated by the Soil Conservation Service (SCS) in accordance with the National Food Security Act Manual, Third Edition (NFSAM).

Wetland Functions

Wetlands perform many useful functions depending on the wetland type and position within the landscape. Landscape position affects both the opportunity to perform these functions and the wetland community that has developed through nutrient and water availability. The following functions are performed by wetlands:

1. Flood conveyance - Riverine wetlands and adjacent palustrine wetlands form natural floodways that convey flood waters from upstream to downstream points.

2. Flood storage - Wetlands act as natural reservoirs by storing water during floods and slowly releasing it to downstream areas, thereby lowering flood peaks.

3. Sediment and erosion control - Wetlands reduce velocity of flood water, which reduces erosion and sediment deposition.

4. Habitat for fish - Wetlands are important spawning areas and provide food sources for fish species.

5. Habitat for waterfowl and other wildlife - Wetlands provide essential breeding, nesting, feeding, and predator escape habitats for many forms of waterfowl, other birds, mammals, and reptiles.

6. Habitat for rare and endangered species - 55 percent of all rare and endangered species in Kentucky are either located in wetland areas or are dependent on them.

7. Recreation - Wetlands serve as recreation sites for fishing, hunting, and observing wildlife.

8. Water supply - With the growth of urban centers and dwindling ground and surface water supplies, wetlands are increasingly important as a source of ground and surface water.

9. Education and research - Inland wetlands provide educational opportunities for nature observation and scientific study.

10. Water Quality - Wetlands improve water quality by removing excess nutrients, sediments, and chemical contaminants.

Wetland Mitigation

Consistent with Section 401 and Kentucky water quality standards, wetland impacts should be avoided or minimized whenever possible. EPA has recommended in its guidance on administering the 401 Water Quality Certification program (discussed further in Chapter 4) that states use the COE regulations as outlined in the 404 (b) (1) guidelines (40 CFR Part 230) when determining whether to issue or deny 401 certifications. When unavoidable impacts occur as a result of the permitting process or as a result of an illegal fill subject to enforcement, mitigation is required to compensate for wetland acreage and functions lost.

Mitigation and monitoring plans are developed in accordance with interagency guidelines that have been prepared by DOW, Louisville COE, U.S. Fish and Wildlife Service, EPA, and Kentucky Department of Fish and Wildlife Resources. The "Wetland Compensatory Mitigation and Monitoring Plan Guidelines for Kentucky" are designed to assist applicants in preparing mitigation plans for agency review. The guidelines outline technical information that should be included to establish and monitor hydric soils, hydrophytic vegetation, and hydrology at the mitigation site. Mitigation usually includes restoration of wetland functions in prior converted cropland sites rather than enhancement or creation of wetlands. The "Guidelines" are currently under revision.

Attainment of functional equivalency should be the goal of all mitigation activities. The choice of restoration, creation, or enhancement mitigation for any project depends upon the site-specific characteristics of available locations. The choice should be

based upon analysis of factors that limit the ecological functioning of the watershed, ecosystem, or region. Mitigation should be initiated either before or at the same time that the proposed project work is being undertaken. The mitigation plan must be made part of the project application. Where an activity does not result in a permanent loss, on-site restoration and compensatory mitigation should occur.

Wetland Classes and Extent

The majority of Kentucky's wetlands are classified as palustrine ecological systems as defined by the U.S. Fish and Wildlife Service's Cowardin classification system that was developed in 1979. Palustrine systems are freshwater wetlands in a concave or depressional landform relative to the surrounding landscape. They are dominated by hydrophytic trees, shrubs, and herbaceous plant species. They are often referred to as bottomland hardwood, floodplain, marsh, oxbow, scrub-shrub, swamp, and wet meadow. Hydrologically, palustrine systems in Kentucky are often linked to an adjacent riverine system; however, hydrologically isolated depressional systems that are maintained by precipitation also occur in the state. Flooding events in palustrine systems are extremely variable during the growing season, ranging from permanently flooded to temporarily flooded areas. Groundwater discharge plays an important role in maintaining surface water depths in many permanently flooded areas. However, even in temporarily flooded areas where surface water may be present for brief periods during the growing season, the water table lies below the soil surface and sustains hydrophytic vegetation and hydric soils.

Riverine systems include all wetlands and deepwater habitats contained within a channel that experience continuously or periodically moving water or connect two bodies of standing water. While wetlands of this type are not extensive in Kentucky, they sustain the surface hydrology for palustrine systems and convey flood waters. The riparian zone of riverine systems provides habitat for wildlife, depresses water temperature through shading, stabilizes stream banks, and reduces sedimentation to streams and wetlands.

Lacustrine systems include deep-water habitats in lakes and reservoirs that are situated in a topographic depression or dammed river channel. Vegetative cover is less than 30 percent, and total area usually exceeds 20 acres. These systems are usually limited in Kentucky to man-made lakes and their associated shorelines and spillways. The subsystems of lacustrine wetlands are described as limnetic (deepwater habitat) and littoral (shoreline habitat).

In 1985, the DOW provided funding to the Kentucky State Nature Preserves Commission to determine the status of Kentucky's wetlands. Recommendations for protection of remaining wetland areas were contained in the report Wetland Protection Strategies for Kentucky (KNPC, 1986). Among the Commission's findings was a rough

estimate that, as of 1978, 637,000 acres remained of the original 1,566,000 acres of palustrine wetlands in Kentucky. Further, it was estimated that only 20 percent of Kentucky's wetland soils remained forested, which reflected a dramatic decline in bottomland hardwood wetlands. The Kentucky Department of Fish and Wildlife Resources estimated Kentucky's annual rate of wetland loss at 3,600 acres (KDFWR 1990). The Environmental Quality Commission (NREPC 1992) reported that only 360,000 acres of palustrine wetlands remained.

In 1988, the Kentucky Department of Fish and Wildlife Resources provided funding to the Natural Resources and Environmental Protection Cabinet (NREPC) to digitize all of the National Wetland Inventory (NWI) maps for Kentucky. The wetlands presented on these maps were identified through the use of stereoscopic analysis of high altitude aerial photography and reflect conditions observed during the period of March 1980 - April 1984. The maps were produced by the U.S. Fish and Wildlife Service's NWI office in St. Petersburg, Florida. The NREPC completed the digitization project in December, 1992.

Based upon the NWI digital information, 323,918 acres of palustrine vegetated wetland exist in the state (Table 2.1). Palustrine systems include forested, scrub-shrub, emergent, and aquatic bed vegetated wetlands. The 1994 305(b) report (Appendix C) provides a breakdown of the acreage of all wetland types as defined in the Cowardin Classification system for waterbodies in the state.

Wetlands as Outstanding Resource Waters

Wetlands classified as Outstanding Resource Waters (ORW) must meet the criteria as designated in 401 KAR 5:031(7). Currently, three of Kentucky's wetlands have been designated as ORWs: Metropolis Lake in McCracken County, Murphy's Pond in Hickman County, and Swan Lake in Ballard County. These ORWs have been designated for the uses of warmwater aquatic habitat and contact recreation. Other wetlands will continue to be evaluated for the ORW designation.

Water Quality Standards for Wetlands

Kentucky water quality standards include wetlands as waters of the state, but do not provide specific wetlands criteria. As waters of the state, wetlands are designated for the uses of warmwater aquatic habitat and contact recreation.

The DOW is working from a grant received in 1991 under Section 104(b)(3) of the Clean Water Act to address deficiencies in the water quality standards regarding wetlands protection. Under this grant, selected wetlands were added to the reference reach monitoring program. Representative wetlands were selected within physiographic regions for monitoring to characterize chemical water quality, sediment quality, fish tissue, habitat condition, and general biotic conditions. From this information, decisions were to be made regarding designation of appropriate use classifications, modifications to numerical chemical criteria, and development of narrative or numerical biocriteria.

However, staff limitations have reduced the current effort in this project, and wetland criteria development is being re-evaluated.

Table 2-1. Acreage of Palustrine Vegetated (PFO, PSS, PEM, PAB) Wetland Types in River Basins of Kentucky

River Basin	Acreage
Big Sandy	860.2
Little Sandy	2,186.2
Tygarts Creek	364.1
Licking	3,274.4
Kentucky	5,507.1
Cumberland	10,759.9
Salt	3,482.0
Green	87,584.0
Tradewater	29,578.4
Lower Cumberland	19,164.5
Tennessee	36,838.2
Mississippi	67,096.9
Ohio River Minor Tribs	40,057.9
Ohio River Mainstem	17,164.2
Total Palustrine Vegetated:	323,918.0

CHAPTER 3

WATER QUALITY ASSESSMENT OF LAKES

WATER QUALITY ASSESSMENT OF LAKES

Section 314 of the Clean Water Act of 1987 requires that states submit a lake water quality assessment as part of their biennial 305(b) report. Six areas to be included in the assessment are:

(1) An identification and classification according to eutrophic condition of all publicly owned lakes in a state.

(2) A general description of the state's procedures, processes, and methods (including land-use requirements) for controlling lake pollution.

(3) A general discussion of the state's plans to restore the quality of degraded lakes.

(4) Methods and procedures to mitigate the harmful effects of high acidity and remove or control toxics mobilized by high acidity.

(5) A list and description of publicly owned lakes for which uses are known to be impaired, including those lakes that do not meet water quality standards or that require implementation of control programs to maintain compliance with applicable standards, and those lakes in which water quality has deteriorated as a result of high acidity that may reasonably be attributed to acid deposition.

(6) An assessment of the status and trends of water quality in lakes including the nature and extent of pollution loading from point and nonpoint sources and the extent of impairment from these sources, particularly with regard to toxic pollution.

The U.S. Environmental Protection Agency (EPA) has developed a guidance document Guidelines for Preparation of the 1996 State Water Quality Assessments, which includes a section on lake assessment reports. Kentucky's report generally complies with the guidelines suggested by the EPA.

Lake Identification

Appendix A3-1 lists publicly owned lakes for which data were available to assess trophic status. Much of this information came from lake surveys conducted in 1989-1991 by the Division of Water (DOW) and Murray State University as part of a cooperative agreement funded under Section 314 of the Clean Water Act. The surveys were conducted on lakes that had originally been sampled by the DOW in 1981-1983 and on 11 lakes that had not previously been surveyed. More recent surveys on a few lakes, conducted by DOW, the U.S. Army Corps of Engineers (COE), Murray State University (Kentucky Lake), and Morehead State University, were also utilized. Not all of the significant publicly owned lakes in Kentucky are included in the table because of the lack of data. For purposes of this report, publicly owned lakes are those lakes that are owned or managed by a public entity such as a city, county, state, or federal agency where

the public has free access for use. A nominal fee for boat launching charged by concessionaires may occur on some of these lakes. Lakes that are publicly owned, but have restricted public access because they are used solely as a source of domestic water supply, are not included. These lakes do not qualify for federal restoration funds under the Clean Lakes Program and were not monitored in the lake classification survey. EPA guidance suggests that all significant lakes be included in state surveys. The term "significant" is to be defined by the state so that all lakes that have substantial public interest and use are included. For this purpose, Kentucky considers all of the publicly owned lakes it has surveyed and listed in Appendix A3-1 and also those that have not yet been surveyed, but qualify as publicly owned lakes, as significant. All of these lakes have substantial local or regional public interest and use.

Trophic Status

Lake trophic state was assessed by using the Carlson Trophic State Index (TSI) for chlorophyll *a*. This method is convenient because it allows lakes to be ranked numerically according to increasing eutrophy and also provides for a distinction (according to TSI value) between oligotrophic, mesotrophic, and eutrophic lakes. The growing season average TSI (chlorophyll *a*) value was used to rank each lake. Growing season was defined as the April through October period. A distinction was made for those lakes that exhibited trophic gradients. Areas of lakes that exhibited trophic gradients or embayment differences were often analyzed separately.

While there are several other methods of evaluating lake trophic state, the accuracy and precision of the chlorophyll *a* analytical procedure (determined from DOW quality control data) and proven ability of the chlorophyll *a* TSI to detect changes made it the index of choice for classifying lakes in Kentucky's program.

Chlorophyll *a* concentration data from the DOW ambient monitoring program and the most current chlorophyll *a* data collected during the spring through fall seasons (a minimum of three samples) by the COE on several reservoirs which they manage were used to update the trophic classifications for this report. Other data were obtained from a study of eastern Kentucky reservoirs by Dr. Brian Reeder of Morehead State University. Data averaged from water column depths of up to 20 feet or composite euphotic zone samples were used in calculating TSI values. Table 3-1 contains the trophic state rankings of lakes of 5,000 acres or more in size, and Table 3-2 lists and ranks the trophic state of lakes less than 5,000 acres in size. Lakes that have updated classifications are in bold face type. A "+" or "-" symbol is used to indicate a trend of increasing or decreasing trophy. Trends were defined as a change of 10 units from a previous TSI score. This represents a doubling or halving of Secchi disk depth and was chosen because it is an observable indication of change.

A summary of Tables 3-1 and 3-2 indicates that of the 104 classified lakes, 60 (57.7 percent) were eutrophic, 33 (31.7 percent) were mesotrophic, and 11 (10.6 percent) were oligotrophic. Three lakes in

Table 3-1
Trophic State Rankings for Lakes
5,000 Acres or Greater in Area
(by Carlson TSI (Chl α) Values)

Lake	TSI (Chl *a*)[a]	Acres
	Eutrophic	
Barkley	61	45,600
Kentucky	53	48,100
	Mesotrophic	
Barren River	50	7,205
Beaver Creek Arm	57 (Eutrophic)	1,565
Skaggs Creek Arm	50	1,230
Green River	48	8,210
Rough River	**46**	**5,100**
Cave Run	45	8,270
Nolin	**45**	**5,790**
	Oligotrophic	
Cumberland	**36**	**49,108**
Pitman Creek Embayment	**50 (Mesotrophic)**	**256**
Lily Creek Embayment	**50 (Mesotrophic)**	**144**
Beaver Creek Embayment	57 (Eutrophic)	742
Laurel River	38	4,990
Midlake-Laurel River Arm	43 (Mesotrophic)	754
Headwaters-Laurel River Arm	52 (Eutrophic)	316
Dale Hollow	33	4,300

[a]Scale: 0-40 Oligotrophic (nutrient poor, low algal biomass)
41-50 Mesotrophic (slightly nutrient rich, moderate amount of algal biomass)
51-69 Eutrophic (nutrient rich, high algal biomass)
70-100 Hyper eutrophic (very high nutrient concentrations and algal biomass)
Bold Type = Updated Classifications

Table 3-2
Trophic State Rankings for Lakes
Less Than 5,000 Acres in Area
(by Carlson TSI (Chl *a*) Values)

Lake	TSI (Chl *a*)[a]	Acres
	Hypereutrophic	
Beaver Dam	86	50
Mitchell	85	58
Happy Hollow	75	20
	Eutrophic	
Swan	69	193
Arrowhead	68	37
Fish	68	27
Spurlington	68	36
Campbellsville City	67	63
Marion County	67	21
Guist Creek	65	317
Wilgreen	65	169
Shelby (Shelby County)	64	17
Buck	64	19
Willisburg	64	126
Briggs	63	18
Kingfisher	63	30
Metropolis	63	36
Flat	62	38
Greenbriar[b]	62	66
McNeely	62	51
Taylorsville	62	3,050
Carpenter	61	64
Jericho	61	137
Sympson	61	184
Burnt Pond	60	10
Long Pond	60	56
Moffit	60	49

Table 3-2 (Continued)

Lake	TSI (Chl *a*)[a]	Acres
Shelby (Ballard County)	60	24
Turner	60	61
Carnico	59	114
Scenic	59	18
A.J. Jolly	58	204
Energy	58	370
Reformatory	**58**	**54**
Corinth	57	96
Freeman	57	160
Sand Lick	57	74
Beaver	56	158
Bullock Pen	56	134
Elmer Davis	56	149
Kincaid	56	183
Malone	56	826
Mauzy	56	84
Metcalfe County	**56**	**22**
Spa	56	240
Washburn	56	26
Boltz	55	92
General Butler	55	29
George	55	53
Fishpond	54	32
Salem	54	99
Shanty Hollow[b]	54	135
Pennyrile	53	47
Williamstown[b]	53	300
Caneyville	52	75
Doe Run	**52**	**51**
Herrington	**52**	**2,940**
Bert Combs	51	36
	Mesotrophic	
Chenoa	50	37
Corbin	50	139
Dewey	50	1,100
Liberty	50	79
Long Run	50	27

Table 3-2 (Continued)

Lake	TSI (Chl *a*)[a]	Acres
Morris	50	170
Beshear	49	760
Hematite	49	90
Honker	49	190
Laurel Creek	49	88
Linville	49	273
Pan Bowl	49	98
PeeWee	49	360
Reba	**49**	**78**
Grayson	48	1,512
Greenbo	48	181
Luzerne	48	55
Mill Creek (Monroe County)	48	109
Smokey Valley	47	36
Tyner	46	87
Wood Creek	46	672
Blythe	45	89
Campton	45	26
Mill Creek (Powell County)	43	41
Yatesville	**42**	**2,242**
Providence City	42	35
Fishtrap	42	1,143
Grapevine	41	50
	Oligotrophic	
Paintsville	**40**	**1,139**
Carr Fork	**39-**	**710**
Cranks Creek	**38**	**219**
Buckhorn	38	1,230
Loch Mary	38	135
Stanford	36	43
Cannon Creek[b]	33	243
Martins Fork	**29-**	**334**

[a]Scale: 0-40 Oligotrophic; 41-50 Mesotrophic; 51-69 Eutrophic; 70-100 Hypereutrophic
[b] = 2 samples only,
(+), (-) means upword (more eutrophic), or downword (less eutrophic) trend
Bold Type = Updated Classifications

eastern Kentucky changed trophic status. Paintsville and Martins Fork lakes changed from a mesotrophic to an oligotrophic state, and Carr Fork Lake changed from a eutrophic to an oligotrophic state. The trophic analysis is based on the status of the major areas of lakes and does not account for the trophic gradient that exists in some reservoirs nor the trophic status of the embayments of others. The dynamic nature of these reservoirs makes it more difficult to assign them a single trophic state because their water residence times, the nature of major inflows, and their morphology can result in different trophic states in separate areas. The tables indicate that trophic gradients exist in Barren River and Laurel River lakes and that certain embayments of Lake Cumberland are either mesotrophic or eutrophic, while the main lake area is oligotrophic.

The 104 assessed lakes have a total area of 217,328 acres. Only those portions of Barkley, Kentucky, and Dale Hollow lakes lying within Kentucky were included in the total. Tennessee reports on those portions within its borders. Of the total, 50 percent (108,151 acres) were eutrophic, 22 percent (46,726 acres) were mesotrophic and 29 percent (62,451 acres) were oligotrophic. The decrease in eutrophic acres from the 1994 305(b) report was because of the lowered trophic state of Lily Creek and Pitman Creek embayments of Lake Cumberland and the dramatic change of Carr Fork to an oligotrophic state. The change in the Lily Creek embayment is related to the decrease in nutrients that were supplied to this embayment by the discharge of the Jamestown sewage treatment plant to Lily Creek. Since the discharge is now to the main lake via a hypolimnetic diffuser, a reduction in trophic state was expected. The change at the Pitman Creek embayment is thought to be due to natural variation. The change at Carr Fork is thought to be related to unsuccessful fertilization of the lake, since its eutrophic status was maintained by fertilization carried out by the Kentucky Department of Fish and Wildlife Resources. The decrease in mesotrophic acreage was because of the changes to oligotrophic status at Paintsville and Martins Fork lakes. These changes are attributable to natural variation. The increase in oligotrophic acreage is because of their inclusion and the addition of Carr Fork.

Lake Pollution Control Activities

Kentucky utilizes several approaches to control pollution in its publicly owned lakes. The approach chosen is dependent upon the pollutant source and the characteristics of each lake. Point sources of potential pollution are more controllable than nonpoint sources. The following procedures are routinely used to control point sources of pollution.

Permitting Program

A lake discharge guidance procedure is applied to any new construction permit for a wastewater treatment facility that proposes to discharge into a lake, or for any application for a lake discharge permit under the Kentucky Pollutant Discharge Elimination System (KPDES). An applicant is required to evaluate all other feasible means of routing the discharge or to explore alternate treatment methods that would result in no discharge to a lake. If

no reasonable alternatives are found, a lake discharge may be permitted. Permits for domestic wastes require secondary treatment and a discharge into the hypolimnion in the main body of the lake. More stringent treatment, including phosphorus removal, may be required depending upon lake characteristics. Surface discharges are not allowed. A permit may also be denied to a prospective discharger if the discharge point is within five miles of a domestic water supply intake.

Nonpoint Source Program

The NPS section of the DOW is engaged in numerous activities that protect Kentucky's lakes. These activities include demonstration projects, education, implementation of best management practices, and technical assistance.

Water Quality Standards Regulations

Kentucky has not adopted specific criteria to protect lake uses. Warmwater aquatic habitat, domestic water supply (if the lake is used for this purpose), and primary and secondary contact recreation criteria are generally applicable to lakes. In specific cases, a provision in the water quality standards regulation can be utilized to designate a waterbody as nutrient limited if eutrophication is a problem. Point source dischargers to the lake and its tributaries can then have nutrient limits included in their permits.

Lakes that support trout are further protected by another provision that requires dissolved oxygen in waters below the epilimnion to be kept consistent with natural water quality.

Kentucky is not planning to adopt statewide criteria specifically for lakes. A site-specific approach to lake pollution control is more realistic, feasible, and scientifically defensible.

Specific Lake Legislation and Local Initiatives

The Kentucky General Assembly passed specific legislation in 1984 to protect Taylorsville Lake. House Joint Resolution No.4 prohibits issuing any discharge permits that allow effluents to be directly discharged into the lake. It also prohibits issuing any permits that allow inadequately treated effluents to be discharged into contributing tributaries that drain the immediate watershed of the lake. In addition, wastewater permit applications in the basin above the lake must be evaluated to ensure that discharges will not adversely affect the lake or its uses. Other provisions provide for stringent on-site wastewater treatment requirements, promotion of nonpoint source controls, and proper management of sanitary landfills in the watershed.

Lake protection associations are not formally organized in Kentucky, although this is a mechanism that has proven to be successful in preventing lake pollution in other states. Local ordinances can be passed that restrict land-use activities and on-site treatment systems and lead to pollution abatement. Local grass roots opposition to activities that may degrade lakes can lead to state agency action. An example is the petition process in the state's surface mining regulations which

can lead to lands being declared unsuitable for mining. Such a petition has been successfully made to protect the water quality of Cannon Creek Lake in Bell County. The lake is used as a water supply for the city of Pineville and is also used for fishing and recreation. A similar petition for Fern Lake, which is the water supply for Middlesboro, has been filed but is unresolved at this time.

In another case, the Lake Cumberland Trust, the Sierra Club, and Trout Unlimited opposed the change in the location of the discharge of the Russell County Regional Wastewater Treatment Plant from a tributary of Lake Cumberland to the main lake. A technical advisory committee consisting of representatives of the parties involved came to a resolution that allowed the discharge but also instituted pollution prevention initiatives by the major wastewater industrial contributor and an assessment of environmental effects. The main lake discharge became operational in April 1993. Two years of sampling have shown that the discharge plume from the diffuser is remaining well below the surface, is not having a harmful effect on the lake's aquatic life, and has not contaminated fish tissue used for human consumption.

Lake Monitoring

Monitoring water quality in lakes is a part of Kentucky's ambient monitoring program and is described in Chapter 1. The objectives of the monitoring program are flexible so that lakes can be monitored for several purposes, including:

- detection of trends in trophic state
- impacts of permit decisions
- ambient water quality characterization
- nonpoint source impacts
- long-term acid precipitation impacts
- pollution incidents such as fish kills and nuisance algal blooms
- new initiatives such as fish tissue analysis for toxics and fecal coliform surveys in swimming areas.

Lake Restoration Plan

Kentucky has not developed a formal state Clean Lakes Program. Several states have adopted programs modeled after the federal Clean Lakes Program and have had state funds appropriated to aid in lake restoration projects. The impetus for developing these programs has been the historical importance of lakes as recreational and aesthetic resources in these states. Pollution or the potential for pollution has prompted support for state development of these programs. Pollution of lakes in Kentucky has not reached a point at which there is a recognized need to develop a state program of this nature.

However, the DOW does participate in the federal Clean Lakes Program. The Natural Resources and Environmental Protection Cabinet is the state agency designated by the Governor to receive federal assistance under this program. Kentucky has received seven assistance awards. Two helped to fund projects that classified lakes in the state according to trophic state and assessed their need for restoration. One award helped to fund a

1993 study conducted by the Big Sandy Area Development District to determine fecal coliform levels in recreation areas of Dewey, Fishtrap, and Paintsville lakes. Another part of that award was used by DOW to start a fish tissue contamination survey of Kentucky lakes. Barkley Lake and Taylorsville Lake were the first two lakes surveyed. A similar project was funded in 1994. DOW surveyed Herrington Lake and Taylorsville Lake for fecal coliform levels to assess recreation impairment and collected fish tissue from McNeely, Guist Creek, Herrington, and Barren River lakes. The Kentucky Department of Fish and Wildlife Resources assisted in the field collections. The fish tissue results from 1993 and the fecal coliform results are reported elsewhere in this report. The fish tissue samples collected in 1994 were sent to a contract laboratory for analysis in March 1996. The results will be reported to the public in a press release. Two projects, through the assistance of state universities, studied the trophic state of selected reservoirs. The other award helped to fund a diagnostic/feasibility study of McNeely Lake in Jefferson County that was completed in 1982.

The DOW cooperated with local and federal agencies in all of these projects and prepared a grant for implementation of the restoration plan for McNeely Lake. The grant was not awarded because McNeely Lake was not technically eligible for assistance under federal guidelines. However, Jefferson County passed a bond issue to finance the implementation of the plan. It was completed in December 1988. The DOW monitored the lake as part of its ambient program and documented water quality improvements that showed the restoration was successful.

The DOW is ready to cooperate with local agencies and other interested groups to participate in the federal Clean Lakes Program. Funding is dependent upon federal appropriations. The preparation of the lake assessment chapter in the 305(b) report is a requirement for future participation in that program.

Toxic Substance Control/Acid Mitigation Activities

Kentucky does not have publicly owned lakes that have high acidity caused by acid precipitation; consequently, this requirement does not apply and will not be addressed.

Identification of Impaired and Threatened Lakes

Table 3-3 summarizes information on overall use support for Kentucky lakes. This information was gathered from published annual reports produced by the COE on reservoirs which they manage, from research reports by other investigators, and from DOW data bases. The total acres assessed equal the acres monitored. The analysis is based on chemical data relating to pH, manganese, and dissolved oxygen problems, biological data relating to algal biomass (blooms), taste and odor problems caused by algae, macrophyte infestations, fish kill reports, and finished drinking water data from public water systems (described in Chapter 1). Criteria were also developed based on other indicators of lake use support (see Table 3-4). A questionnaire was sent to

Table 3-3
Summary of Lake Use Support

Degree of Use Support	Acres Monitored[a]	Percent (by acres)
Acres Fully Supporting	101,939[b]	47
Acres Supporting But Threatened	97,779	45
Acres Partially Supporting	18,192	8
Acres Not Supporting	452	<1
Total Acres Assessed	218,362[b]	

[a]Total Kentucky Lake Acreage - 228,385
[b] Includes 16 additional (1,034 acres) lakes assessed by Phase II - Phase V drinking water program

operators of drinking water facilities that use lakes as raw water sources to assess use impairment. They responded to questions relating to taste and odor problems and the degree of treatment used to combat the problem. One of the criteria for support of aquatic life indicates that a use was partially supported if the average dissolved oxygen concentration within the epilimnion at any sampling event was between 4 and 5 mg/l and not supported if the dissolved oxygen was less than 4 mg/l.

The total lake surface area reported in Table 3-3 (228,385 acres) is based on the DOW's Dam Inventory Files and the acres inventoried in the lake classification program. The assessed acres represent more than 90 percent of the publicly owned lake acreage in the state. EPA published a draft document in October 1993 that updated a previous document titled Total State Waters: Estimating River Miles and Lake Acreages for the 1992 Water Quality Assessments (305(b) Reports). Total lake acreage reported for Kentucky was 225,097 acres. The acreages are derived from USGS 1:24,000 scale maps for lakes shown on the USGS 1:100,000 scale map series. The DOW derived its higher estimate of lake acreages from engineering drawings in its Dam Inventory Files, from reported acres (at certain elevations) in U.S. Army Corps of Engineers project reports of its major reservoirs in the state, and by planimetering USGS 1:24,000 scale maps for lakes with no reported acres. These are considered to be more accurate estimates than those reported by EPA. Total surface area of lakes in the state is unknown.

Many lakes have been classified by use in Kentucky and are listed in Kentucky's water quality standards. Waters not specifically listed by use in regulations are

Table 3-4
Criteria for Lake Use Support Classification

Category		Warmwater Aquatic Habitat		Secondary Contact Water Recreation	Domestic Water Supply
Not Supporting:		(At least two of the following criteria)		(At least one of the following criteria)	(At least one of the following criteria)
	1.	Fish kills caused by poor water quality	1.	Widespread excess macrophyte/macro-scopic algal growth	1. Chronic taste and order complaints caused by algae
	2.	Severe hypolimnetic oxygen depletion	2.	Chronic nuisance algal blooms	2. Chronic treatment problems caused by poor water quality
	3.	Dissolved oxygen average less than 4 mg/l in the epilimnion			3. Exceeds drinking water MCL
Partially Supporting:					
(At least one of the following criteria)	1.	Dissolved oxygen average less than 5 mg/l in the epilimnion	1.	Localized or seasonally excessive macrophyte/macro-scopic algal growth	1. Occasional taste and odor complaints caused by algae
	2.	Severe hypolimnetic oxygen depletion	2.	Occasional nuisance algal blooms	2. Occasional treatment problems caused by poor water quality
	3.	Other specific cause (i.e. low pH)	3.	High suspended sediment concentrations during the recreation season	
			4	Other specific cause (i.e. low pH)	
Fully Supporting:					
	1.	None of the above	1.	None of the above	1. None of the above

contact recreation (swimming), secondary contact recreation, fish consumption, and domestic water supply at points of domestic water supply intakes. Primary contact recreation was not assessed because routine sampling was not conducted for the primary indicator of use support (fecal coliform bacteria). The DOW has begun a program to monitor a few large lakes for fecal coliform bacteria in recreation areas in order to determine primary contact use support. This program was discussed earlier in this chapter.

Detailed information on previously assessed lakes can be found in the report on the lake classification program titled Trophic State and Restoration Assessments of Kentucky Lakes, published in 1984 by the DOW. Detailed information on newly assessed lakes has been included in a final report of the lake assessment project. DOW plans to reproduce the report for public distribution in the near future. Appendix A3-1 lists summary information on all of the lakes assessed.

Table 3-5 and Table 3-6 list lakes that did not support or partially supported their uses. The tables indicate the criteria from Table 3-4 that were used to determine nonsupport or partial support and the probable causes and sources for the support not being achieved. Table 3-7 lists those lakes that fully support their uses.

Table 3-8 summarizes individual use support information for lakes based on acres and number of lakes. More than 91 percent of the total acres assessed supported uses, and less than 9 percent did not fully support uses. Of the 120 lakes assessed, 86 (72 percent) fully supported their uses, 28 (23 percent) lakes partially supported uses, and 6 (5 percent) lakes did not support one or more uses. Of lakes more than 5,000 acres in size, only Green River Lake did not fully support uses. Herrington Lake was removed from the nonsupport list and placed in the supporting but threatened category because of improved water quality. Metcalfe County and Reformatory lakes were added to the nonsupport category because dissolved oxygen concentrations were below state standards. Laurel Creek, Liberty, and Morris lakes are being upgraded from the partial-support category to the full-support category. A study by DOW of suspended solids effects on recreation use in eastern Kentucky reservoirs resulted in the upgrade of Martins Fork and Fishtrap lakes from the partial-support category to the full-support category. A successful aeration and grass carp introduction by the Kentucky Department of Fish and Wildlife Resources removed aquatic weed and low dissolved oxygen problems at Carpenter Lake, thus moving it from partial-support to full support status. Fish consumption concerns arose in Green River Lake during this reporting period. Advisories are in effect against eating carp and channel catfish because of contamination from PCBs. Swimming in waters contaminated by bacteria was not considered to be a problem in any of the lakes. Also, there were no significant violations of drinking water maximum contaminant levels at any of the 57 water supply lakes where finished drinking water was sampled.

Table 3-5
Lakes Not Supporting Uses

Lake	Use Not Supported[a]	Criteria[b]	Cause	Source
Briggs	WAH	2,3	Nutrients	Lake fertilization
Corbin	DWS	1	Nutrients	Municipal point sources and agricultural nonpoint sources
Loch Mary	DWS	2	Metals (Mn) and other inorganics (noncarbonate hardness)	Surface mining (abandoned lands)
Mauzy	WAH	2,3	Nutrients	Lake fertilization
Metcalfe Co. nonpoint sources	WAH	2,3	Nutrients	Agriculture
Reformatory operations	WAH	2,3	Nutrients	Livestock

[a]WAH - Warmwater Aquatic Habitat, SCR - Secondary Contact Recreation, DWS - Domestic Water Supply
[b]Refer to Table 3-4

Table 3-6
Lakes Partially Supporting Uses

Lake	Use[a]	Criteria[b]	Cause	Source
Beshear	WAH	1	Nutrients	Natural
Buckhorn	SCR	3	Suspended solids	Surface mining
Campbellsville	WAH	1	Nutrients	Agricultural nonpoint sources
	SCR	1	Shallow Lake Basin	Natural
Caneyville	DWS	1	Nutrients	Natural
	SCR	1	Shallow Lake Basin	Natural
Carr Fork	SCR	3	Suspended solids	Surface mining
Cranks Creek	WAH	3	pH	Mining (abandoned lands)
	SCR	3	pH	Mining (abandoned lands)
	PCR	3	pH	Mining (abandoned lands)
Dewey	SCR	3	Suspended solids	Surface mining
George	WAH	1	Nutrients	Agricultural nonpoint sources
Grapevine	DWS	1	Nutrients	Unknown
Green River	FC	N/A	Priority organics (PCBs)	Industrial point source
Guist Creek	DWS	1	Nutrients, Metals (Mn)	Agricultural nonpoint sources, Natural
	WAH	1	Nutrients	Agricultural nonpoint sources
Honker	WAH	1	Nutrients	Natural
Jericho	WAH	2	Nutrients	Agricultural nonpoint sources
Kincaid	WAH	1	Nutrients	Unknown
Luzerne	DWS	2	Nutrients	Unknown
Marion County	SCR	2	Nutrients	Lake fertilization
McNeely	WAH	1,2	Nutrients	In-place contaminants (Sediments)

Table 3-6 (Continued)

Lake	Use[a]	Criteria[b]	Cause	Source
Pewee	DWS	1	Nutrients	Agricultural nonpoint sources
Salem	SCR	1	Shallow Lake Basin	Natural
Sand Lick Creek	WAH	1	Nutrients	Agricultural nonpoint sources
	SCR	1	Shallow Lake Basin	Natural
Scenic	WAH	1	Nutrients	In-place contaminants (sediments)
Shelby (Shelby Co.)	WAH	1	Nutrients	Agricultural nonpoint sources/In-place contaminants (sediments)
Spa	WAH	1	Nutrients	Agricultural nonpoint sources
	SCR	1	Shallow Lake Basin	Natural
Stanford	DWS	1	Nutrients	Natural
Taylorsville	WAH	2,3	Nutrients	Agricultural nonpoint sources
Wilgreen	WAH	2	Nutrients	Septic tanks
	SCR	2	Nutrients	Septic tanks
Washburn	WAH	2	Nutrients	Unknown
Wood Creek	DWS	1	Nutrients	Septic tanks

[a]WAH - Warmwater aquatic habitat, SCR - Secondary contact recreation, DWS - Domestic water supply, FC - Fish consumption, N/A - not applicable

[b]Refer to Table 3-4

Table 3-7
Lakes Fully Supporting Uses

Size		
5000 Acres or Larger	**Less than 5000 Acres**	
Barkley	A.J. Jolly	Linville
Barren	Arrowhead	Long Pond
Cave Run	Beaver	Long Run
Cumberland	Beaver Dam	Malone
Dale Hollow	Bert Combs	Martins Fork
Kentucky	Blythe	Metropolis
Laurel River	Boltz	Mill Creek
Nolin	Buck	(Monroe Co.)
Rough River	Bullock Pen	Mill Creek
	Burnt Pond	(Powell Co.)
	Campton	Mitchell
	Cannon Creek	Moffit
	Carnico	Morris
	Carpenter	Paintsville
	Chenoa	Pan Bowl
	Corinth	Pennyrile
	Doe Run	Providence City
	Elmer Davis	Reba
	Energy	Shanty Hollow
	Fish	Shelby (Ballard Co.)
	Fish Pond	Smokey Valley
	Fishtrap	Spurlington
	Flat	Swan Pond
	Freeman	Sympson
	General Butler	Turner
	Grayson	Tyner
	Greenbo	Williamstown
	Greenbriar	Willisburg
	Happy Hollow	Yatesville
	Hematite	
	Herrington	
	Kingfisher	
	Laurel Creek	
	Liberty	

Table 3-8
Use Support Summary for Lakes

Use	Supporting	Supporting But Threatened	Partially Supporting	Not Supporting
		(by Acres)		
Fish Consumption[a]	209,118	0	8,210	0
Aquatic Life[a]	159,404	52,179	5,567	178
Swimming[a]	217,109	0	219	0
Secondary Contact[a]	119,606	93,700	4,022	0
Drinking Water[b]	189,045	0	1,572	274
		(by Number)		
Fish Consumption[c]	103	0	1	0
Aquatic Life[c]	79	3	19	3
Swimming[c]	102	0	2	0
Secondary Contact[c]	90	2	12	0
Drinking Water[d]	48	0	7	2

[a]Total Assessed Acres = 217,328
[b]Total Assessed Acres for Domestic Water Supply = 190,891
[c]Total Assessed Lakes = 104
[d]Total Assessed for Domestic Water Supply = 57

Table 3-9
Threatened Lakes

Lake	Use Threatened[a]	Cause	Source
Kentucky	SCR	Macrophyte infestations	Natural or introduced exotic species
	WAH	Low dissolved oxygen	Unspecified nonpoint sources
Paintsville	WAH	Salinity/brine	Petroleum activities
Barkley	SCR	Suspended solids	Unspecified nonpoint sources
Herrington	WAH	Low dissolved oxygen	Unspecified nonpoint sources, municipal point sources, septic tanks

[a]SCR - Secondary Contact Recreation, WAH - Warmwater Aquatic Habitat

Table 3-10
Causes of Use Nonsupport[a] In Lakes

Major Impact[b]	Number of Lakes Affected	Acres	Percent Contribution (by Acres)
Nutrients	28	6,941	36
Priority organics (PCBs)	1	8,210	42
Suspended solids	3	3,040	16
Other (shallow lake basin)	5	498	3
pH	1	219	1
Metals (Mn)	2	452	2
Other inorganics (noncarbonate hardness)	1	135	<1

[a]Nonsupport is a collective term for lakes either not supporting or partially supporting uses
[b]No moderate or minor impacts were noted

EPA guidance asks for a list of threatened lakes. These are defined as lakes that fully support uses now, but may not in the future because of anticipated sources of or adverse trends in pollution. Table 3-3 indicates the total acres classified as threatened. Table 3-9 lists the lakes, uses threatened, and the causes and sources of the threats.

Table 3-10 indicates the causes responsible for nonsupport of uses in lakes. As noted in previous 305(b) reports, nutrients affected the largest number of lakes. Nutrients can stimulate growth of algae, which may cause taste and odor problems in lakes used for domestic water supplies. Dissolved oxygen can also be lowered by very productive algal populations that stimulate microbial respiration and may result in fish kills or a decrease in oxygen to levels that are not conducive to the support of healthy populations of fish. Priority pollutants (PCBs) affected only Green River Lake, but the entire lake (8,210 acres) was determined to not be meeting the fish consumption use. Suspended solids, the third largest contributor to nonsupport of uses, caused some reservoirs in eastern Kentucky to only partially support secondary contact recreational uses.

Table 3-11 indicates the sources responsible for nonsupport of lake uses. Industrial sources (40 percent), and nonpoint sources (41 percent) accounted for the highest percentage of lake acres with use nonsupport. More detailed studies in watersheds of the lakes in the agriculture category are necessary before contributing sources of nonpoint pollution can be distinguished. Surface coal mining and septic tanks are the other nonpoint source contributors to lake uses not being fully supported. Lake recreational uses are impaired because waters become turbid after receiving runoff laden with sediment from lands disturbed by surface mining activities. This turbidity reduces the incentive for secondary contact uses. Septic tank leachate contains nutrients that cause eutrophication and can impair aquatic life and domestic water supply uses. Natural causes and municipal point sources accounted for nine and less than one

percent of use nonsupport, respectively.

Special Studies - Lake Cumberland

Sampling in Lake Cumberland was conducted in 1994 and 1995 to assess the effects of a discharge from the Russell County Regional Wastewater Treatment Plant (which includes a significant contribution from a Union Underwear facility) into the lake through a submerged multiport diffuser. Sampling of the thermally stratified lake by Jamestown and the DOW in late summer and early fall of both years indicated that pollutant concentrations were low and that the effluent remains well below the surface. These plume surveys detected increased conductivity and chloride in a thin (2-4 feet) layer at distances of almost 5,000 feet from the diffuser, but chloride concentrations were less than 15 mg/l. Near-field samples were taken for the first time in 1994 by divers from both the DOW and Jamestown. Samples were collected directly out of the pipe and at the edge of the zone of initial dilution (7 ft) to compare field results to earlier modeling predictions from which several permit limits were derived. Chloride concentrations in the 7-foot samples were highly variable, ranging from 6 to 180 mg/l, probably because of

Table 3-11
Sources of Use Nonsupport[a] in Lakes

Contributions Source	Major Impact (Acres)	Moderate/Minor Impact (Acres)	Percent (by Acres)
Point Sources			
Industrial	8,210		42
Municipal	139		<1
Nonpoint Sources			
Agriculture	4,526		23
Septic Tanks	841	317	6
Surface Mining	3,175		16
Other			
Natural	1,861		10
Lake fertilization	123		<1
In-place contaminants	86		<1
Unknown	314		2

[a]Nonsupport is a collective term for lakes either not supporting or partially supporting uses.

the turbulent nature of the plume at close proximity to the discharge ports. Kentucky's acute aquatic life criterion for chloride, applicable at the edge of the zone of initial dilution, is 1200 mg/l. Chloride samples taken from the edge of the mixing zone (70 ft) ranged from 9 to 34 mg/l. This compares to upstream control station concentrations of 1-4 mg/l and a chronic aquatic life water quality criterion applicable at the edge of the mixing zone of 600 mg/l. Total recoverable copper concentrations never exceeded 0.006 mg/l at any of the water quality monitoring sites outside the zone of initial dilution or 0.007 mg/l at the edge of the zone of initial dilution. These levels compare to background concentrations that were very low (0.001-0.003 mg/l) or undetectable, a chronic aquatic life criterion of about 0.008 to 0.010 mg/l, and an acute criterion of about 11-14 mg/l (copper criteria are dependent on water hardness).

Samples collected during unstratified conditions of February 1995 did not detect any increase in chlorides outside the mixing zone. Concentrations within the mixing zone were also much lower than during stratified conditions. These results were not unexpected because the lack of density differences in the receiving water allows more complete mixing of the effluent.

Studies by the DOW did not detect any appreciable differences in nutrient levels or phytoplankton biomass downstream of the diffuser compared to an upstream control station. Fish tissue and sediment samples did not indicate any significant differences between samples collected upstream and downstream of the diffuser. Zooplankton densities downstream of the diffuser did show significant reduction in the samples from the fall of 1994, but species richness was not affected. Further decreases of nutrients and biomass in the Lily Creek embayment, which previously received the effluent via Lily Creek, were also found.